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*Research Article*

# Study on the Intention of Private Parking Space Owners of Different Levels of Cities to Participate in Shared Parking in China

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The implementation of shared parking program can effectively increase the utilization rate of existing parking space resources. At present, shared parking program has not been widely practiced in China, and the prerequisite for this prospect to be implemented is whether the private parking space owner group can quickly and widely accept shared parking program. In this study, considering the differences in the economic development, urban planning, and parking pressure in cities of different levels, the theory of planned behavior and the benefit-risk perception model (C-TPB-BRA) are combined as the theoretical framework to explore the intention to share parking space from the perspective of the owners of private parking spaces in cities of different levels. Based on China's empirical data, structural equation models are built to verify the hypotheses proposed. Our results show that (a) the intention of private parking space owners in different levels of cities to participate in shared parking and the mechanism of action of the psychological factors are different, and not all psychological factors have a direct impact on the intention to share. In first-tier, second-tier, and third-tier cities, Subjective Norm (SN) and Perceived Behavioral Control (PBC) indirectly affect Behavior Intention (BI) through Attitude (ATT), Perceived Benefit (PB), and Perceived Risk (PR). In the fourth-tier cities, SN and PBC directly affect BI. Except for BI, other psychological factors influence each other significantly; (b) the psychological factors affecting the intention to supply shared parking spaces in first-tier, second-tier, third-tier, and fourth-tier cities, respectively, are PB > ATT > PR, PB > PR > ATT, PB > PR > ATT, and PB > SN > PBC > ATT > PR. Our research results could help determine the internal factors that affect the intention of parking space suppliers and their mechanisms of action to participate in shared parking, and on that basis, our findings could also help governments and platform operators to promote shared parking development plans.

## 1. Introduction

In recent years, the economy has developed rapidly and the number of motor vehicles has increased greatly, but the infrastructure construction and management level have not been correspondingly improved, so the contradiction between supply and demand of parking has become increasingly prominent. In addition, according to relevant statistics [1], in the context of sudden public health incidents such as the COVID-19, citizens are more concerned about the hygiene of public transportation and shared bicycles, resulting in a further reduction in the proportion of public transport trips, and the proportion of private car trips increased, which will further intensify parking needs.

In addition, Amott [2] pointed out that, in Boston and some major European cities, more than 50% of cars need to find parking spaces during peak hours. The research of Shoup [3] pointed out that if each parking activity requires three minutes to find a parking spot, the cruising mileage of each vehicle needs to be increased by about 1825 kilometers per year. Besides, the lack of parking spaces can also lead to illegal parking activity, increased time costs caused by queuing and waiting, etc., thereby exacerbating carbon dioxide emissions [4]. This situation is more serious in many cities in China. Zhao et al. [5] constructed a quantitative model to evaluate the emission reduction effect of the implementation of the shared parking policy. The results show that 120 shared parking spaces in Beijing can reduce about 400 tons of carbon dioxide emissions a year; if 20% of

the existing parking spaces in Beijing are shared, every year carbon dioxide emissions can be reduced by up to 7.3 million tons. Ayala [6] found that more than 3.1 million gallons of gasoline was wasted and more than 48,000 tons of carbon dioxide was emitted due to the search for parking spaces in Chicago. Therefore, if the problem of parking difficulty can be solved, the parking pressure can be effectively alleviated, the driver's time to find parking is greatly reduced, and the environmental pollution caused by vehicle emissions can be alleviated.

In addition to the contradiction between supply and demand of parking, another prominent manifestation of the current urban parking problem is the inefficient utilization of parking resources, which is mainly reflected in the imbalance in the space-time utilization of parking resources. For example, parking spaces in office areas are usually vacant at night and on weekends, while parking spaces in residential areas are often vacant during workdays during the day, which also provides an opportunity to meet parking demand without the need to build more parking lots [7]. According to relevant statistics, 485,000 parking spaces in Hong Kong are designated for private use, accounting for nearly 70% of the total number of parking spaces; Beijing's residential parking resources account for 58.1% of all parking resources, during working hours nearly 800,000 private parking spaces have been left unused [8], and because most urban residents work inconsistently with their homes, parking spaces in residential areas have been unused during the day on weekdays. If the spare time of these private parking spaces can be used effectively, the parking problem can be greatly alleviated.

In recent years, the concept of shared parking has been proposed, the basic idea of which is that the parking space owner sells parking permits for the idle period of their parking spaces to public users on the electronic parking platform [9], and travelers with parking needs can purchase a parking permit through the parking platform. The relationship between supply and demand is shown in Figure 1. Some cities have already experimented with shared parking, but private parking space sharing in residential areas is still in its infancy. Most urban residents do not know much about shared parking in residential areas, and the number of users of each shared parking platform is small, so participation in shared parking is far from enough. Therefore, it is very important for urban planning and parking management to understand the decision-making mechanism for people to accept shared parking.

In the context of the sharing economy, previous behavioral research mainly focused on the behavioral intentions of demanders. However, it must be noted that, in the sharing practice, the supplier plays an equally important role [10]. Shared parking spaces are essentially private goods, and their supply comes from individuals whose purpose is to obtain certain benefits. Their participation in decision-making plays a decisive role in the development of shared parking. Therefore, it is very important to explore the mechanism of influencing factors of private parking space owners' intention to provide shared parking spaces.

Therefore, use the theory of planned behavior and the benefit-risk perception model (C-TPB-BRA) as the theoretical framework. This paper explores the differences of parking space sharing intention and the mechanism of psychological factors from the perspective of the suppliers of shared parking spaces in cities of different levels. Based on China's empirical data, the structural equation models are built to verify the hypothesis proposed. Our research aims to determine intrinsic factors that affect the intention to share parking spaces and their mechanisms of action.

The rest of the paper is structured as shown in Figure 2: Section 2 reviews and summarizes the literature on shared parking. Section 3 introduces the theoretical model framework of this research and puts forward the research hypothesis. Section 4 introduces the design of the questionnaire, data analysis, model evaluation, and results analysis. Section 5 puts forward corresponding policy recommendations based on the analysis results. Finally, the main content of this study is summarized and the future research directions are introduced in Section 6.

## 2. Literature Review

The relevant research on this topic involves the following three aspects: parking selection behavior and matching and pricing of shared parking spaces.

In terms of parking selection behavior, some scholars conducted SP (Stated Preference) and RP (Revealed Preference) survey considering time factors, economic factors, external information, traffic safety, and other information and constructed the model of parking choice behavior by using prospect theory [11]. Some scholars used the RP/SP survey to collect data related to the traveler's parking space choice behavior and then constructed multiple Logit, nested Logit, and mixed Logit to calibrate the model of parking space search time [12–14]. Besides, aiming at the driver's competitive choice behavior under the condition of limited parking space resources, Guo et al. [15] further collected relevant behavioral data through experiments and performed a dynamic model to study the traveler's parking space choice behavior.

In the related research on the matching of shared parking spaces, in view of the low utilization rate of private parking spaces in the community during working days, Shao et al. [16] established a parking space matching model between residential parking spaces and parking space users. Apart from that, some scholars constructed the matching model based on GIS [17], cloud technology [18], and the double auction mechanism [19]. In addition, Zhao et al. [20] proposed a shared parking resource management framework from considering the uncertainty of the arrival time and departure time of P-users and O-users and then developed an intelligent parking management system (IPMS) to simulate the operation of shared parking. Wang [21] developed a dynamic optimal supply strategy for parking permits and constructed a stochastic optimal control model to minimize the expected value of the total time loss of the system.

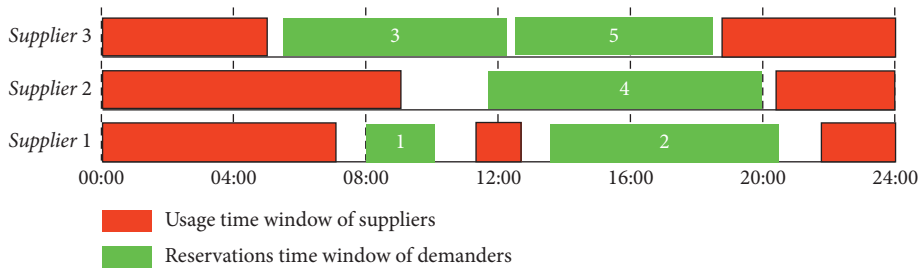



Figure 1: Supplementary graph of supply and demand for shared parking spaces.

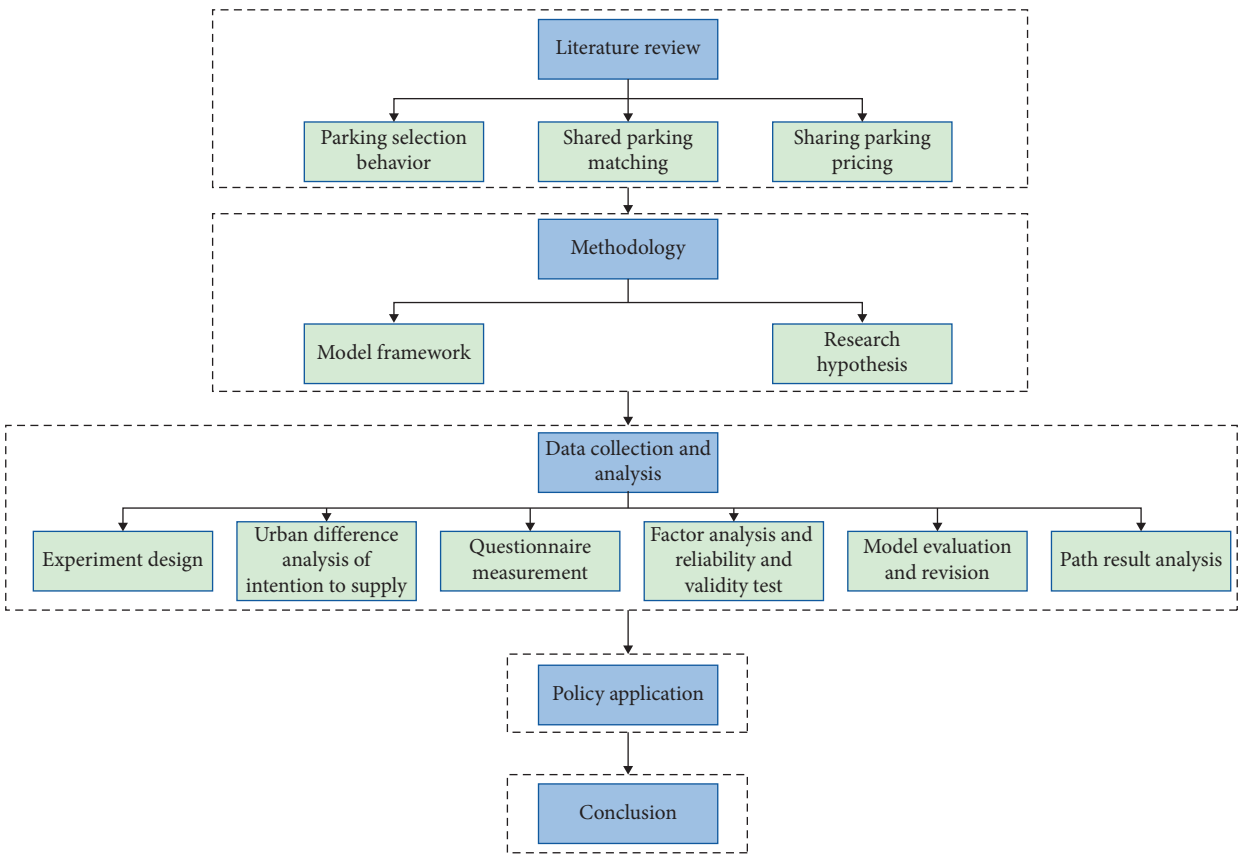



Figure 2: The framework of this study.

The charging of shared parking is the most important factor that affects the intention of shared parking supply and demand parties to participate. At present, there are many studies on parking pricing, such as parking pricing strategies based on the marginal cost principle and suboptimal pricing theory [22, 23] and the demand-side competitive auction mechanism based on distribution rules and transaction payment rules [24]. In 2020, Xiao [25] designed two auction-based shared parking pricing strategies in a dual environment that includes parking suppliers and demanders. Based on the Internet of vehicles technology, some scholars used cloud computing to match the supply and demand of shared parking spaces and then determined the shared parking rate [18]. In addition, there is related study on the allocation-pricing-revenue mechanism of shared parking spaces [26].

From the existing literature on shared parking, there are few studies on the sharing intention of private parking space owners and due to the large differences in economic levels, urban planning, parking pressure, and information popularization among cities of different levels, there may also be differences in the intention of private parking space owners in different levels of cities to supply shared parking spaces. In response to this problem, this paper uses the C-TPB-BRA as the theoretical framework and constructs the structural equation models of cities of different levels to verify the proposed hypothesis based on China's empirical data. This study aims to predict the intention of private parking space owners in different levels of cities to provide shared parking spaces and determines the mechanism of action of each influencing factor on the sharing intention under different

urban development forms. Finally, we propose policy recommendations based on the calculation results. The findings could provide decision-making basis for different regions to develop shared parking plans tailored to local conditions.

## 3. Methodology

### 3.1. Basic Theory and Theoretical Framework

*3.1.1. TPB.* Social psychology is the theoretical system that focuses on the psychology of people in a social environment, which studies the laws of the psychological and behavioral occurrence and change of individuals and groups in social interaction. Its representative theory is the TPB. According to TPB, human behavior is totally or partially affected by BI, ATT, SN, PBC, and other psychological factors [27]. ATT refers to an individual's positive or negative feelings about the behavior; SN refers to the social pressure that an individual feels about whether to take a particular behavior, that is, when predicting the behavior of others, the influence of individuals or groups that have influence on the individual's behavioral decision-making on whether an individual takes a particular behavior; PBC refers to the obstacles that reflect the individual's experience and expectations. The more resources and opportunities at your disposal and the fewer expected obstacles, the stronger your perceived behavioral control over behavior. BI refers to the judgment of an individual's subjective probability of taking a particular behavior, which reflects an individual's intention to take a particular behavior. TPB provides a theoretical basis for explaining the influence of psychological factors on behavioral choices [28, 29].

However, because shared parking is not widely used in China, actual behavior data of which is not easy to obtain, and BI can explain behavior well. Therefore, in this study, BI is used to predict actual behavior. Although TPB has strong universality in practice, it cannot fully explain the actual behavior under any circumstances, and there are some missing factors [30–32]; that is, in addition to the above factors, the BI may still be affected by some other undiscovered hidden factors.

*3.1.2. BRA Model.* While sharing parking brings rental benefits to parking space suppliers, it also brings risks such as hidden safety hazards to residential areas. Therefore, the psychological game between risks and benefits will also affect the intention to supply parking spaces. The benefit-risk analysis (BRA) model is often used in behavior research. It points out that Perceived Benefits (PB) and Perceived Risks (PR) are important variables that affect users' behavioral intention. Users make behavioral choices after weighing benefits and risks. At the same time, PB and PR will affect individual behavior attitude and behavior intention. The BRA model believes that PB is more likely to be influenced and driven by emotions than PR. Zeithaml [33] defined the PB in 1988 as the overall evaluation of the utility of the product or service after weighing the value that the user perceives when receiving the product or service and the cost paid by the user. The core of the evaluation is to weigh the PB and PR. Jacoby et al. [34] divided the PR of customers into economic risk, functional risk, physical risk, psychological risk, social risk, and time risk. Sweeney [35] proposed that perceived value includes social value, quality value, price value, and emotional value. Although different scholars have different views on the division of perceived value in different fields, the overall situation is mainly composed of two parts: PB and PR.

*3.1.3. Structural Equation Model.* Structural equation model (SEM) is a statistical method that expresses the relationship between observed variables and latent variables, as well as the relationship between latent variables using the linear equation system. Its core idea is to set observation variables for the latent variables and then through the relationship between observation variables to indirectly reflect the relationship between latent variables [36]. ATT, SN, PBC, PB, PR, and BI involved in this paper are all latent variables that cannot be directly observed, and the corresponding observed variables have been listed in Table 1. Structural equation model which can be set by matrix equation and path diagram includes measurement equation and structural equation. The matrix equations are expressed as follows:

$$X = A_X \xi + \delta, \tag{1}$$

$$Y = A_Y \xi + \varepsilon, \tag{2}$$

$$\eta = B_\eta + \Gamma \xi + \zeta. \tag{3}$$

Equations (1) and (2) are the measurement equations, and (3) is the structural equation where $X$ is the exogenous observed variable vector, such as ATT1 and other measured variables in Table 1; $\xi$ indicates the exogenous latent variable vector, such as ATT and PBC; $A_X$ represents the relationship between the exogenous observed variable and the exogenous latent variable, that is, the factor loading matrix of the exogenous observed variable with the exogenous latent variable; $\delta$ is the residual item vector of the exogenous observed variable; $Y$ represents the endogenous observed variable vector; $\eta$ is the endogenous latent variable vector, that is, the BI; $A_Y$ indicates the relationship between the endogenous observed variable and the endogenous latent variable; $\varepsilon$ is the relationship between endogenous observed variable and endogenous latent variable; $B$ indicates the relationship between endogenous latent variables; $\Gamma$ represents the influence of exogenous latent variable on endogenous latent variable; $\zeta$ is the error term of the structural equation.

*3.1.4. Combined Theoretical Framework.* Therefore, based on the TPB and BRA model, this paper constructs a combined theoretical framework (C-TPB-BRA) explaining the relationship between psychological factors and behavioral intentions and establishes structural equation models for the intention of parking space suppliers in different levels of cities. As shown in Figure 3, the constructed framework includes six potential variables, PR, PB, ATT, SN, PBC, and BI; the arrows represent the influence relationship; and the mutual influence relationship is represented by double arrows.

Table 1: Descriptive statistics of observed variables.

| Latent variable | Item number | Measurement item | Adapted source |
|---|---|---|---|
| ATT | ATT1 | I agree with the idea of supplying shared parking spaces. | Ajzen [26] |
| | ATT2 | I think it's wise to supply shared parking. | |
| | ATT3 | I think it's a good thing to supply shared parking spaces. | |
| SN | SN1 | If there is an opportunity, I think most people around me would choose to supply shared parking. | Chen [37] |
| | SN2 | If there is an opportunity, I think my family will suggest and support me to supply a shared parking space. | |
| | SN3 | If there is an opportunity, I think my friends/classmates/colleagues will suggest and support me to supply a shared parking space. | |
| | SN4 | The support and appeal of the government and media will make me more willing to supply shared parking spaces. | |
| | SN5 | The greater the number of owners who supply shared parking spaces in a small area, the more I am willing to supply shared parking spaces. | |
| PBC | PBC1 | It is easy for me to supply shared parking spaces through the shared parking system. | Davis [38] |
| | PBC2 | I believe I can supply shared parking spaces through a shared parking system. | |
| | PBC3 | I have a lot of knowledge to supply shared parking spaces through the shared parking system. | |
| | PBC4 | I think I have complete control over the use of the shared parking system. | |
| | PBC5 | If the operation of the shared parking system is easy to understand, I am more willing to supply shared parking spaces. | |
| | PBC6 | If a shared parking credit mechanism is established, I would prefer to supply shared parking spaces. | |
| | PBC7 | When a parker uses my parking space over time, I am more willing to supply a shared parking space if the shared parking platform provides me with a spare parking space. | |
| | PBC8 | When a parker uses my parking space over time, I am more willing to supply a shared parking space if the sharing parking platform provides me with subsidies. | |
| PR | PR1 | I think it is very likely that the parker will park over time, which will cause more inconvenience to me personally. | Im [39] |
| | PR2 | I feel that supplying a shared parking space may expose my personal privacy (such as travel records, home address, etc.). | |
| | PR3 | I think if the parked car has an accident in the neighborhood, it will probably get me into trouble. | |
| | PR4 | I think supplying shared parking will increase the cost of new equipment and redevelopment of the parking lot. | |
| | PR5 | I think supplying shared parking space will increase the pressure of property management in the community. | |
| PB | PB1 | I think I can get a lot of money by supplying a shared parking space. | Lee [40] |
| | PB2 | I think supplying a shared parking space for others will give me a sense of achievement and satisfaction. | |
| | PB3 | I think supplying shared parking spaces can help solve other people's parking problems. | |
| | PB4 | I think supplying shared parking spaces will improve the utilization rate of idle parking spaces. | |
| | PB5 | I think the provision of shared parking spaces contributes to the sustainable development of the city. | |
| BI | BI1 | If there is an opportunity, I would like to try to supply shared parking spaces through the shared parking system in the future. | Tan [41] |
| | BI2 | If there is an opportunity, I would like to give priority to supplying shared parking spaces through the shared parking system in the future. | |
| | BI3 | If there is an opportunity, I will often supply shared parking spaces through the shared parking system in the future. | |
| | BI4 | In the future, I will strongly recommend to my friends and family to participate in the shared parking program. | |

*3.2. Research Hypothesis.* According to the proposed combined theoretical framework and related references, the following hypotheses are proposed.

According to Huijts's [42] points, ATT and SN all have a positive effect on the intention to act. Chen's [43] work has shown that, for motorcycle and car users, SN and PBC have a key influence on intention. Therefore, we propose the following hypotheses:

H1: ATT has a positive effect on BI.

H2: SN has a positive effect on BI.

H3: PBC has a positive effect on BI.

Wu and Lin [44] found that SN have a direct impact on ATT. When respondents receive positive support or encouragement from relatives, friends, or other social organizations for their behavior, their ATT will also become more positive. As private parking spaces are shared products

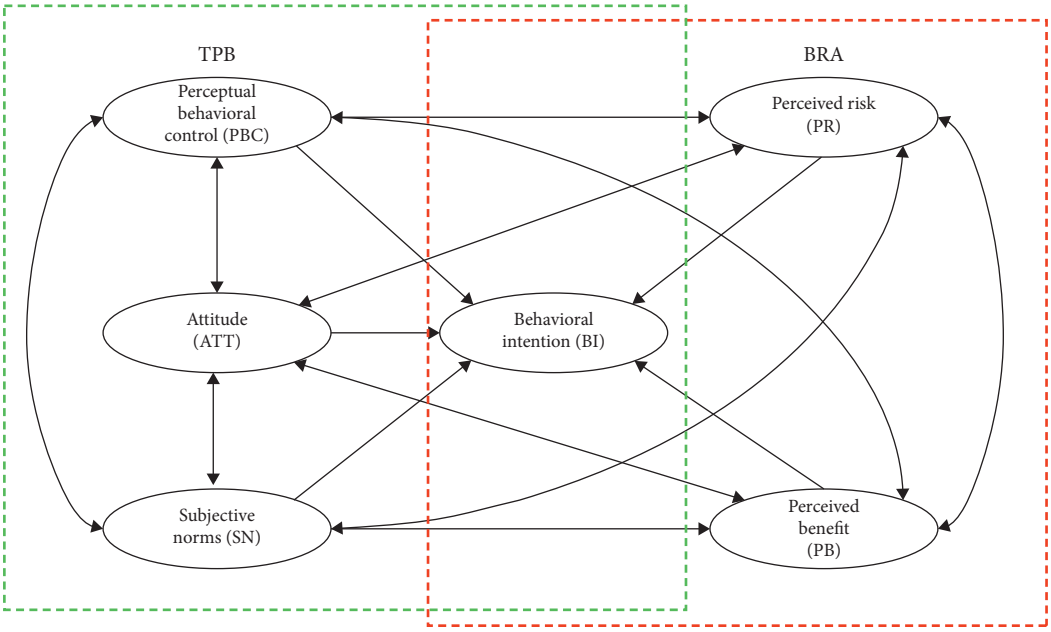



Figure 3: Mixed theoretical framework for this study.

of the family, the views of family members will also have an impact on the intention of decision maker. Therefore, we propose the following hypotheses:

H4: there exists a significant relationship between ATT and SN.

When Yu et al. [45] constructed a causal model to study the tourism behavior of Taiwanese tourists in Kinmen in 2005. They found that ATT played a role as an intermediary variable in the influence of PBC on BI, indicating PBC has a positive effect on ATT. Similarly, Tsai [46] proved through canonical correlation analysis that PBC influences ATT. Therefore, we propose the following hypotheses:

H5: there exists a significant relationship between ATT and perceptual behavior control.

H6: there exists a significant relationship between PBC and SN.

Hae-Kyung Sohn's [47] research results show that PR can lead to people's negative perception of festivals. Liao [48] explored the proenvironmental behavioral intention based on environmental ATT and the relationship between PB and the purchase choices of energy-saving appliances in Chinese households. The research results show that behavioral intention has a significant positive impact on the purchase choices of energy-saving appliances. ATT and psychological benefits have a significant positive impact on the respondents' intention to purchase energy-saving equipment. Lee's [40] research results show that the intention to use online banking is mainly negatively affected by security/privacy risks and financial risks and is mainly positively affected by PB and ATT. Therefore, we propose the following hypotheses:

H7: PR has a negative effect on BI.

H8: PB has a positive effect on behavioral intentions.

H9: there exists a significant relationship between PB and PR.

Mary [49] examined the causal influence of PR and PB as well as SN on users' intention to adopt cloud technology trust and found that PR and PB have a significant impact on SN. Therefore, we propose the following hypotheses:

H10: PR is negatively associated with ATT, PBC, and SN.

H11: PB is positively associated with ATT, PBC, and SN.

## 4. Data Collection and Analysis

*4.1. Experimental Design.* In order to ensure the data quality of the questionnaire, a presurvey was conducted before the formal survey. We asked people with varying degrees of understanding of shared parking to fill out the questionnaire, and after deleting inappropriate items, we got the formal questionnaire. We used online questionnaire for the formal survey. According to the statistical data of the National Bureau of Statistics of China and related literature [50, 51], in the questionnaire, cities with a population of over 20 million are defined as first-tier cities, including Beijing and Shanghai. Cities with a population of 10 to 20 million are defined as second-tier cities, including Tianjin, Chongqing, Jinan, and Hangzhou. The cities with a population of 2 to 10 million are defined as third-tier cities, such as Haikou and Luoyang. Cities with a population of less than 2 million are defined as fourth-tier cities, such as Changde and Xiaogan.

In the questionnaire, participants are asked to read a brief introduction about shared parking and then answer the relevant questions, which aim to ensure that the respondent really understands the operation process involved in shared parking. The survey is mainly aimed at people who have private parking spaces in urban areas. According to the geographical location information of the surveyed people, it is found that the surveyed people come from 31 provinces in China (a total of 33 provinces) and are evenly distributed in first-tier cities, second-tier, third-tier, and fourth-tier cities

and 673 questionnaires are collected. After conditional screening, the number of valid questionnaires is 625 (the effective rate is 92.3%). When using structural equations for multivariate research, the sample size should be at least 5 times the variable; that is, the sample size for a formal survey is appropriate more than 150 copies, so the sample size of the formal investigation can meet the research needs. The questionnaire consists of three parts: the first part includes the social and economic attributes of the respondent; the second part covers the built environment of the respondent's residential area and the use of parking spaces, such as public transportation accessibility, surrounding land types, and parking spaces idle time; the third part covers the measurement of variables in C-TPB-BRA, including ATT, SN, PBC, BI, PR, and PB.

The basic information and socioeconomic attributes of the surveyed participants include gender, age, monthly income, education level, the number of private cars, and the number of private parking spaces. Among them, there are slightly more male respondents (58.58%) than females (41.42%) in the overall sample; respondents are mainly aged from 26 to 60 years of age (70.16%), which is more in line with the age characteristics of private parking spaces; 68.63% of the population are with college/bachelor degree and above; the income of the respondents is evenly distributed between 3000 and 11000 yuan/month (75%), indicating that the surveyed group has a certain degree of universality. Table 2 summarizes the main demographic characteristics of the valid samples of cities at different levels.

*4.2. Urban Difference Analysis of Intention to Supply.* Through the questionnaire, we investigated "Do you agree to open the community to share parking spaces?" and "Do you want the residential area near your company to be opened to share parking spaces?" Figure 4 shows the statistics of the survey results. We found interesting conclusions: as for "Do you agree to open the community to share parking spaces?", the agreement and disagreement ratios of different levels of urban groups are all over 40% and close to 1 : 1, indicating that there is a lot of potential development space for shared parking in residential areas. Regarding "Do you want to share parking spaces in residential areas near your unit?", among different levels of urban groups, the agreeing group account for about 60%, and the neutral group account for about 20%, indicating that most residents recognize the value of shared parking.

*4.3. Questionnaire Measurement.* In this study, all psychological variables (C-TPB-BRA variables) were measured using the Likert five-level scale (1 = completely disagree; 5 = completely agree). The higher the score, the higher the degree of agreement. Based on the existing related research on TPB and BRA model, we made corresponding modifications to the measurement variables according to the research questions. The six latent variables of the research question include a total of 30 measurement items, of which ATT includes three items (ATT1-ATT3), SN includes five items (SN1-SN5), PBC includes eight items (PBC1-PBC8), PR contains five items (PR1-PR5), PB contains five items (PB1-PB5), and BI contains four items (BI1-BI4). Table 1 lists specific measurement items in detail.

*4.4. Factor Analysis and Reliability and Validity Test.* First, we use SPSS to perform exploratory factor analysis, and we carry out KMO and Bartlett's sphere test on the scale. The calculation results are shown in Table 3. The results show that KMO values are all above 0.880 (>0.700), and Bartlett's sphere test value is significant (Sig.<0.001), indicating that the questionnaire data meets the prerequisite requirements of factor analysis.

Reliability and validity are used to measure the accuracy and stability of questionnaire test results [52]. Reliability analysis is used to measure whether the results of the questionnaire are reliable, and Cronbach's coefficient (Cronbach's $\alpha$) is generally used for evaluation. If Kronbach's coefficient is higher than 0.8, the reliability is high; if it is between 0.7 and 0.8, the reliability is acceptable; if it is between 0.6 and 0.7, it is basically acceptable; if it is less than 0.6, the reliability is not good. It is necessary to consider revising the survey scale [53]. Table 3 shows the reliability and validity test results of each latent variable. From the results, Cronbach's coefficient of each latent variable is higher than 0.8, indicating that the reliability of the questionnaire is very high.

Validity analysis is used to measure the validity and accuracy of the design of problem items. The higher the validity is, the more accurate the measurement results are. Validity is usually verified by using Average Variance Extracted (AVE) and when the value is greater than 0.5, which indicates that the latent variable has good convergence validity. In addition, when the load coefficient of the standardized factor corresponding to each observed variable is greater than 0.6 and $P < 0.05$, it also shows that the convergence validity is up to standard. From the results in Table 4, the AVE of each latent variable is above 0.63, and the value of each observed variable is above 0.66, indicating that the data has strong reliability and internal consistency.

*4.5. Model Evaluation and Modification.* Based on the combined theoretical framework in Figure 1, the structural equation models were established using AMOS for path verification. The preliminary verification found that the theoretical model and the empirical data could not be completely fitted. Therefore, the SEMs were revised without affecting the integrity of the theoretical model. The path that has no significant impact at all is deleted, and the final model fitness test index calculation results are shown in Table 5. The optimized model fitness of different levels of cities is significantly better than the initial theoretical model. Indicators of the first-tier, second-tier, and third-tier cities meet the requirements except that the AGFI is slightly lower than the standard value. Although RMSEA and AGFI are slightly lower than the standard value, other indicators of the fourth-tier cities meet the requirements, indicating that the model fit meets the standard requirements.

Table 2: Personal attribute information statistics of interviewees.

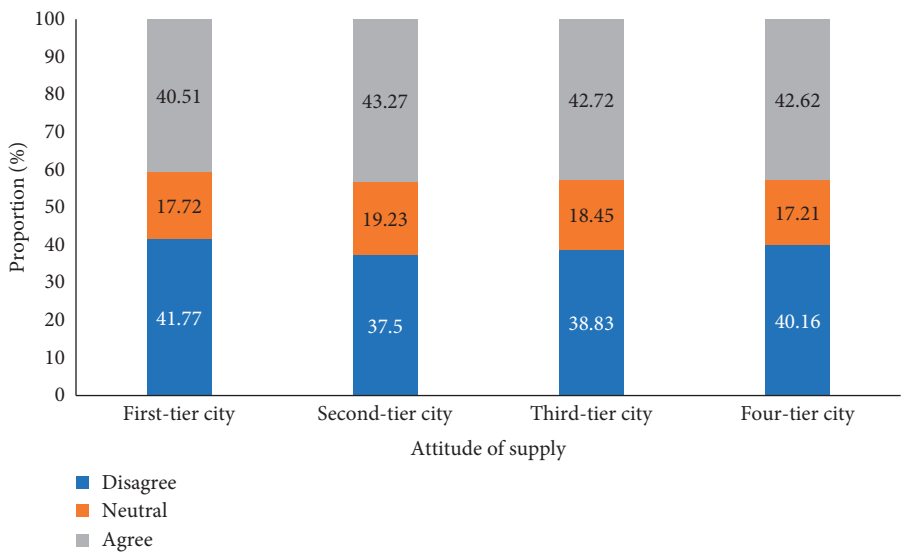
| Group | Description | | Proportion of first-tier cities (%) | Proportion of second-tier cities (%) | Proportion of third-tier cities (%) | Proportion of fourth-tier cities (%) |
|---|---|---|---|---|---|---|
| Gender | Gender 1 | Male | 67.09 | 59.62 | 53.40 | 56.56 |
| | Gender 2 | Female | 32.91 | 40.38 | 46.60 | 43.44 |
| Age | Age 1 | 18–25 | 22.78 | 22.12 | 36.89 | 27.05 |
| | Age 2 | 26–30 | 22.70 | 18.27 | 9.71 | 5.74 |
| | Age 3 | 31–40 | 31.65 | 34.62 | 11.65 | 12.3 |
| | Age 4 | 41–50 | 8.86 | 14.42 | 17.48 | 18.85 |
| | Age 5 | 51–60 | 2.53 | 6.73 | 22.33 | 32.79 |
| | Age 6 | >60 | 5.06 | 0.96 | 0.97 | 0.00 |
| Education level | Level 1 | High school or below | 16.46 | 19.23 | 35.92 | 47.54 |
| | Level 2 | College/ Undergraduate | 30.38 | 43.27 | 39.81 | 38.52 |
| | Level 3 | Master | 41.77 | 29.81 | 19.42 | 13.11 |
| | Level 4 | Doctor | 11.39 | 7.69 | 4.85 | 0.82 |
| Monthly income | Income 1 | <3000 *yuan* | 18.99 | 16.35 | 30.1 | 31.97 |
| | Income 2 | 3000–5000 *yuan* | 11.39 | 17.38 | 25.24 | 27.05 |
| | Income 3 | 5000–7000 *yuan* | 6.33 | 20.12 | 23.3 | 18.85 |
| | Income 4 | 7000–9000 *yuan* | 15.19 | 12.50 | 6.80 | 11.48 |
| | Income 5 | 9000–11000 *yuan* | 8.86 | 8.65 | 3.88 | 5.74 |
| | Income 6 | >11000 *yuan* | 39.24 | 25.00 | 10.68 | 4.92 |
| Number of private parking spaces | Number 1 | 1 | 77.22 | 71.15 | 74.76 | 72.95 |
| | Number 2 | 2 | 17.72 | 18.27 | 19.42 | 20.49 |
| | Number 3 | >3 | 5.06 | 10.58 | 5.83 | 6.56 |
| Understanding of shared parking | Level 1 | Do not understand at all | 5.06 | 5.77 | 6.8 | 11.48 |
| | Level 2 | Do not understand | 32.91 | 27.88 | 29.13 | 22.95 |
| | Level 3 | General understanding | 32.91 | 43.27 | 41.75 | 54.92 |
| | Level 4 | Better understand | 17.72 | 17.31 | 16.5 | 9.02 |
| | Level 5 | Understand very well | 11.39 | 5.77 | 5.83 | 1.64 |

The revised SEMs are shown in Figures 5(a)–5(d). The values on the paths in Figure 5 are the standardized path coefficient, which reflect the magnitude of the impact. From the calibration results of the models, we can see the mutual causality between the latent variables of the combined theoretical model of different levels of cities.

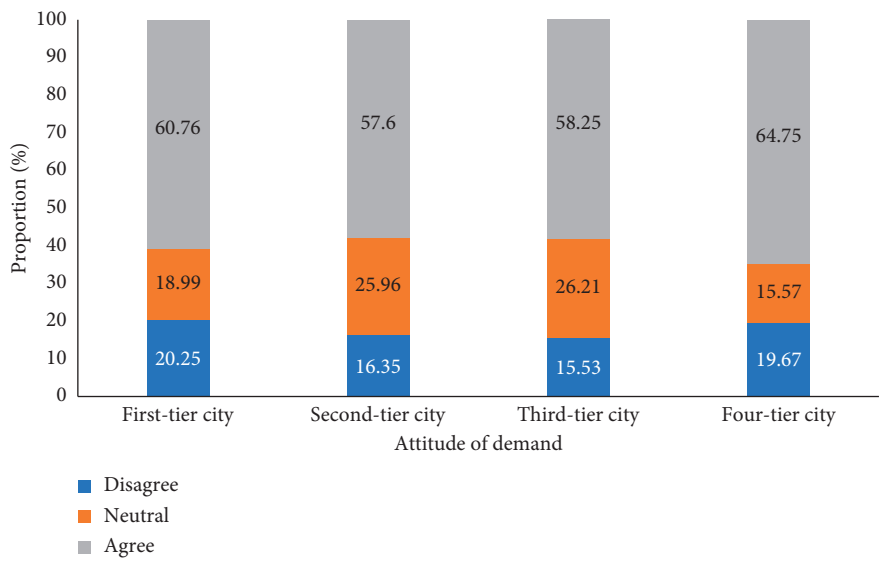
*4.6. Path Result Analysis.* The path results of the parking space sharing intention model of different levels of cities in Figures 5(a)–5(d) are sorted out, and the inference results are shown in Table 6.

(1) Table 7 lists the influence degree of latent variables that have a direct impact on BI. We can see that the most influential psychological factor affecting the intention to supply parking spaces in cities of all different levels is PB. The factors that directly affect the intention to share parking spaces in first-tier cities are PB > ATT > PR. SN and PBC mainly indirectly affect BI by affecting "ATT > PB"; that is, ATT and PB play an intermediary role. The factors that directly affect the intention to share parking spaces in second-tier cities are as follows: PB > PR > ATT; SN and PBC indirectly affect BI by affecting "PB > ATT > PR"; PB, ATT, and PR play an intermediary role. The factors that directly affect the intention to share parking spaces in third-tier cities are PB > PR > ATT, while SN and PBC mainly affect BI and PR by affecting "PB > ATT". The intermediary effect of PR is not strong; while the factors that affect the intention to share parking spaces in fourth-tier cities are as follows: PB > SN > PBC > ATT > PR. PR has the least direct impact, indicating that shared parking space suppliers in fourth-tier cities are not sensitive to the hidden risks brought by parking space sharing.

(2) In the structural equation models of cities of different levels, ATT has a significant impact on BI, especially in first-tier cities and third-tier cities, which validates H1. In first-tier cities, second-tier cities, and third-tier cities, neither SN nor PBC has significant influence on BI, but indirectly influences BI through ATT, possibly because




(a)




(b)

Figure 4: (a) Statistical results of shared parking space supply intention. (b) Statistical results of shared parking space demand intention.

Table 3: KMO and Bartlett's test results.

| Indicator | First-tier cities | Second-tier cities | Third-tier cities | Fourth-tier cities | Standard scope |
|---|---|---|---|---|---|
| KMO | 0.895 | 0.906 | 0.911 | 0.888 | >0.700 |
| Sig. | 0.000 | 0.000 | 0.000 | 0.000 | <0.001 |

shared parking has not been widely applied in practice, so there is little difference in perception of the difficulty of use. Similarly, the research conclusions in literature [43] also confirmed that ATT is a mediating variable between PBC and BI. In addition, Neoh [54] also concluded that responsibilities to family members (which are very similar in function to SN) can have a positive but insignificant influence on the driver's intention. Therefore, H2 and H3 are not supported in the SEMs of the first-tier, second-tier, and third-tier cities. However, in the fourth-tier cities, SN and PBC have a significant impact on BI, indicating that H2 and H3 are supported in the SEM of fourth-tier cities. This similar conclusion has also been verified [55].

Table 4: Reliability and validity test results.

| Variable | | CFA | | | | α | | | | AVE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| ATT | ATT1 | 0.913 | 0.942 | 0.963 | 0.942 | 0.958 | 0.946 | 0.958 | 0.971 | 0.884 | 0.853 | 0.888 | 0.920 |
| | ATT2 | 0.970 | 0.895 | 0.944 | 0.982 | | | | | | | | |
| | ATT3 | 0.936 | 0.933 | 0.92 | 0.953 | | | | | | | | |
| SN | SN1 | 0.711 | 0.876 | 0.706 | 0.835 | 0.950 | 0.963 | 0.903 | 0.972 | 0.796 | 0.842 | 0.651 | 0.881 |
| | SN5 | 0.815 | 0.939 | 0.854 | 0.959 | | | | | | | | |
| | SN3 | 0.852 | 0.968 | 0.825 | 0.98 | | | | | | | | |
| | SN4 | 0.823 | 0.905 | 0.768 | 0.969 | | | | | | | | |
| | SN5 | 0.780 | 0.896 | 0.87 | 0.943 | | | | | | | | |
| PBC | PBC1 | 0.964 | 0.776 | 0.889 | 0.777 | 0.974 | 0.964 | 0.967 | 0.974 | 0.820 | 0.771 | 0.784 | 0.815 |
| | PBC2 | 0.96 | 0.824 | 0.851 | 0.903 | | | | | | | | |
| | PBC3 | 0.919 | 0.837 | 0.893 | 0.884 | | | | | | | | |
| | PBC4 | 0.925 | 0.794 | 0.756 | 0.81 | | | | | | | | |
| | PBC5 | 0.913 | 0.757 | 0.919 | 0.954 | | | | | | | | |
| | PBC6 | 0.906 | 0.785 | 0.94 | 0.97 | | | | | | | | |
| | PBC7 | 0.834 | 0.734 | 0.921 | 0.958 | | | | | | | | |
| | PBC8 | 0.811 | 0.663 | 0.903 | 0.945 | | | | | | | | |
| PR | PR1 | 0.869 | 0.554 | 0.748 | 0.857 | 0.935 | 0.910 | 0.907 | 0.952 | 0.745 | 0.674 | 0.667 | 0.805 |
| | PR2 | 0.889 | 0.686 | 0.886 | 0.905 | | | | | | | | |
| | PR3 | 0.928 | 0.743 | 0.855 | 0.989 | | | | | | | | |
| | PR4 | 0.781 | 0.613 | 0.806 | 0.893 | | | | | | | | |
| | PR5 | 0.841 | 0.776 | 0.782 | 0.834 | | | | | | | | |
| PB | PB1 | 0.616 | 0.720 | 0.661 | 0.771 | 0.914 | 0.900 | 0.939 | 0.958 | 0.696 | 0.632 | 0.774 | 0.826 |
| | PB2 | 0.814 | 0.793 | 0.881 | 0.873 | | | | | | | | |
| | PB3 | 0.888 | 0.765 | 0.951 | 0.975 | | | | | | | | |
| | PB4 | 0.909 | 0.817 | 0.949 | 0.936 | | | | | | | | |
| | PB5 | 0.906 | 0.872 | 0.923 | 0.972 | | | | | | | | |
| BI | BI1 | 0.918 | 0.958 | 0.948 | 0.957 | 0.977 | 0.957 | 0.976 | 0.982 | 0.914 | 0.851 | 0.913 | 0.932 |
| | BI2 | 0.985 | 0.870 | 0.969 | 0.994 | | | | | | | | |
| | BI3 | 0.956 | 0.935 | 0.966 | 0.963 | | | | | | | | |
| | BI4 | 0.964 | 0.924 | 0.938 | 0.946 | | | | | | | | |

*Note.* 1, 2, 3, and 4, respectively, represent cities of corresponding levels.

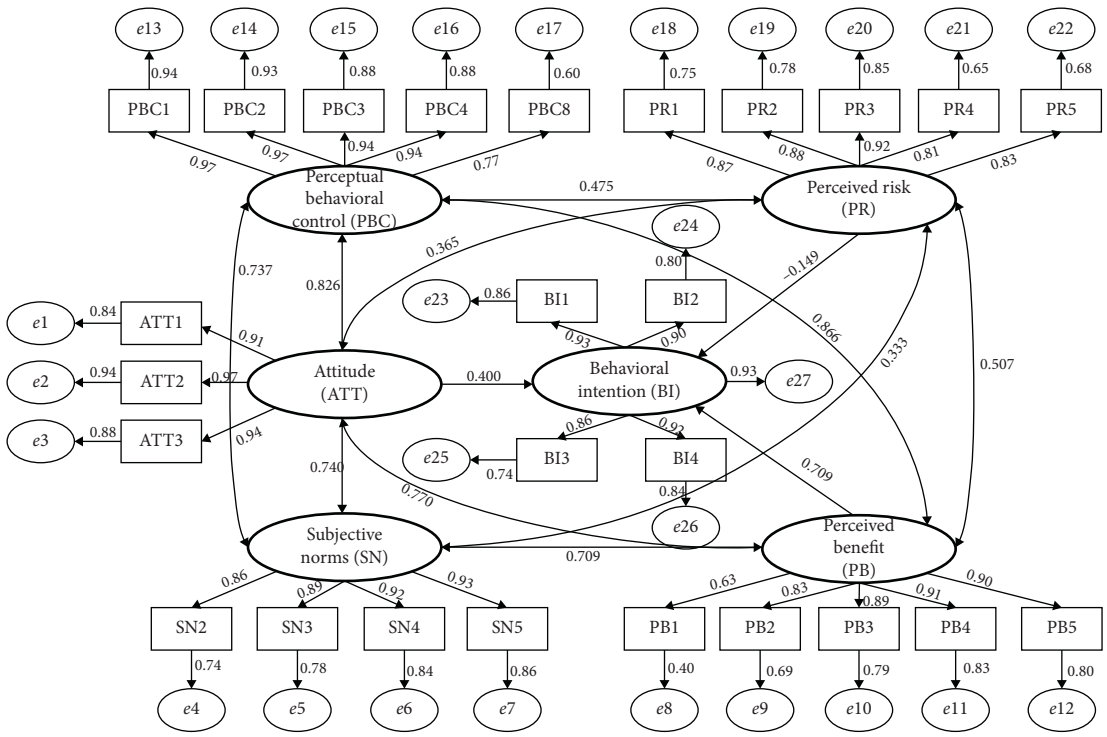
Table 5: SEM fitting index results.

| Indicator | 1 | | 2 | | 3 | | 4 | | Standard scope |
|---|---|---|---|---|---|---|---|---|---|
| | TM | OM | TM | OM | TM | OM | TM | OM | |
| $\chi^2/df$ | 2.516 | 2.037 | 2.814 | 2.229 | 2.749 | 2.132 | 3.317 | 2.027 | [1, 3] |
| RMSEA | 0.140 | 0.032 | 0.135 | 0.05 | 0.139 | 0.045 | 0.143 | 0.075 | <0.06 |
| GFI | 0.576 | 0.956 | 0.645 | 0.921 | 0.584 | 0.968 | 0.706 | 0.893 | >0.90 |
| CFI | 0.864 | 0.966 | 0.853 | 0.904 | 0.854 | 0.908 | 0.897 | 0.958 | >0.90 |
| NFI | 0.796 | 0.938 | 0.791 | 0.940 | 0.791 | 0.942 | 0.861 | 0.920 | >0.90 |
| IFI | 0.866 | 0.910 | 0.854 | 0.905 | 0.856 | 0.909 | 0.898 | 0.958 | >0.90 |
| AGFI | 0.476 | 0.866 | 0.561 | 0.843 | 0.485 | 0.879 | 0.616 | 0.810 | >0.90 |

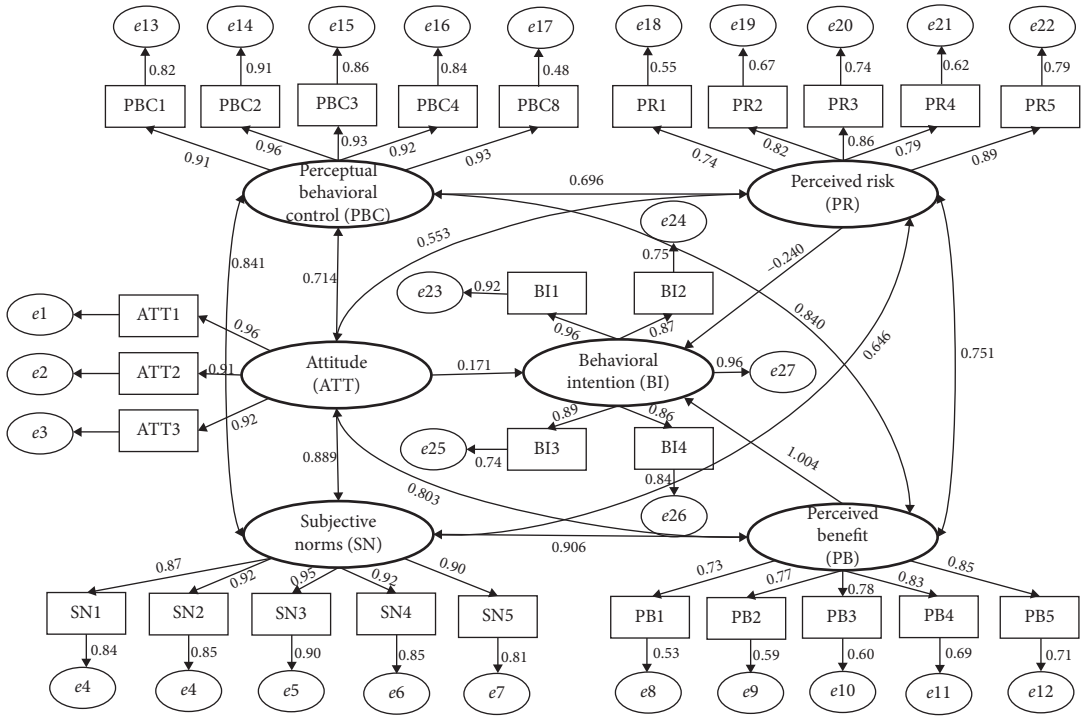
Note: 1, 2, 3, and 4, respectively, represent cities of corresponding levels. TM indicates theoretical model; OM represents optimized model.

(3) In the SEMs of the four levels of cities, SN, PBC, PR, and PB all have a significant impact on ATT, indicating that the attitude of shared parking space suppliers is influenced by the recognition of the society and the surrounding people, as well as the anticipated benefits and risks of participation; thus H4 and H5 are supported and H10 and H11 are supported partially. Meanwhile, SN is positively associated with PBC, which also confirms H6.

(4) In the four SEMs, PR has a significant negative impact on BI, so H7 is supported, which shows that the greater the risk perceived by the shared parking space supplier, the weaker the intention to supply shared parking spaces, such as the overtime use of parking spaces by the renters, and the security risks brought by the entry of other vehicles into the community will have a negative impact on the intention to provide shared parking spaces. Especially in second-tier cities and third-tier




(a)




(b)

Figure 5: Continued.

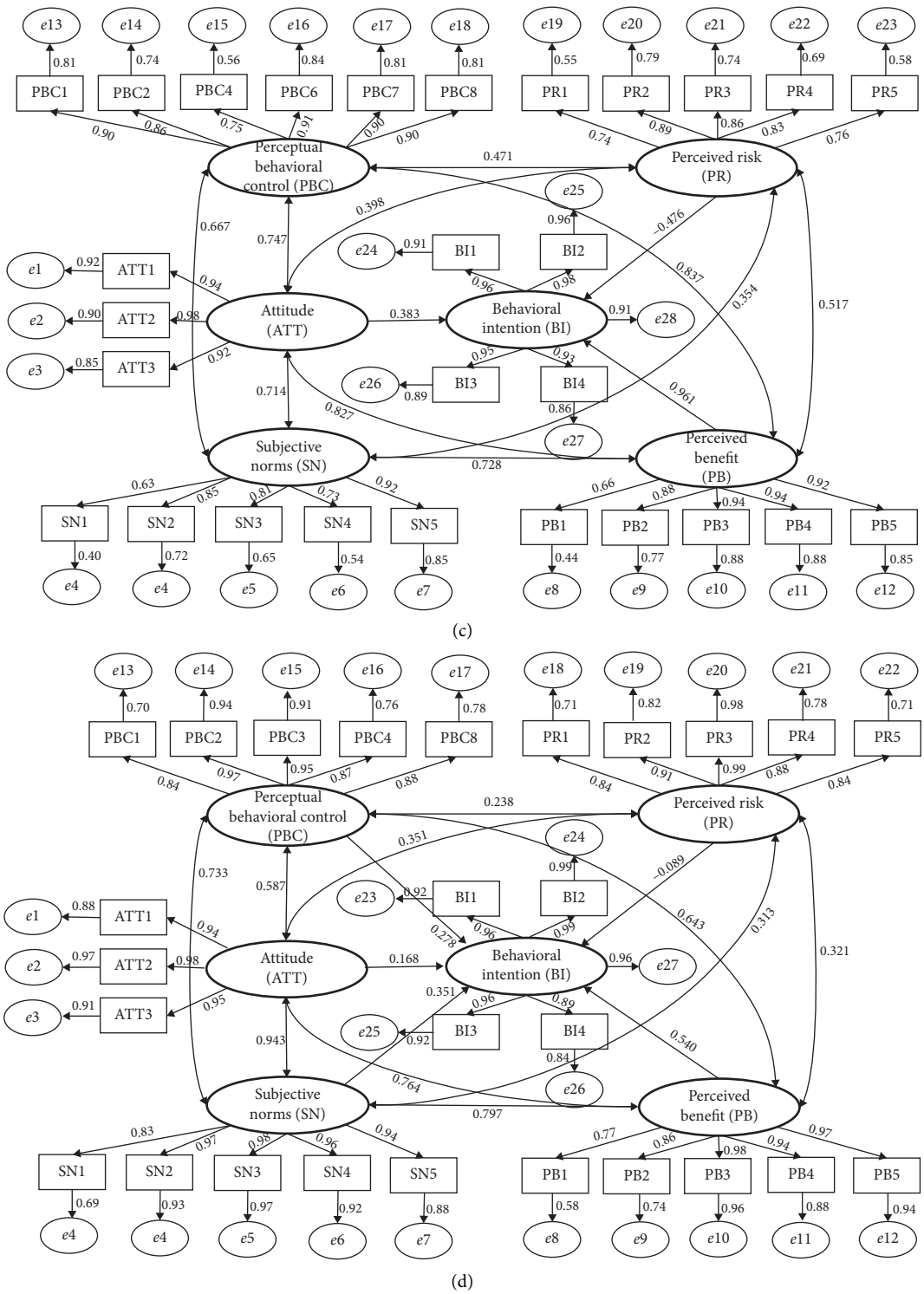



Figure 5: (a) Modified results of the optimized model for first-tier cities. (b) Modified results of the optimized model for second-tier cities. (c) Modified results of the optimized model for third-tier cities. (d) Modified results of the optimized model for fourth-tier cities.

cities, this negative impact is more significant, but the impact is relatively weak in first-tier cities and fourth-tier cities, which may be related to the overall management level of residential areas in cities of different levels. Similarly, PR has a significant impact on PB, indicating the compensation effect of PB on PR, so the greater the PB of the parking space supplier, the greater PR tolerance strong; thus H9 is supported. Both PBC and SN have a significant impact on PR, so H10 is supported.

Table 6: Test results of the proposed hypotheses.

| Path | First-tier city | | | Second-tier city | | | Third-tier city | | | Fourth-tier city | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *PC* | PV | Inference | *PC* | PV | Inference | *PC* | PV | Inference | *PC* | PV | Inference |
| H1: ATT ⟶ BI | 0.40 | *** | Supported | 0.17 | *** | Supported | 0.38 | *** | Supported | 0.17 | 0.02 | Supported |
| H2: SN ⟶ BI | 0.15 | 0.43 | Not supported | 0.20 | 0.31 | Not supported | −0.03 | 0.96 | Not supported | 0.35 | *** | Supported |
| H3: PBC ⟶ BI | 0.05 | 0.71 | Not supported | −0.10 | 0.32 | Not supported | 0.40 | 0.35 | Not supported | 0.28 | *** | Supported |
| H4: ATT↔SN | 0.74 | *** | Supported | 0.89 | *** | Supported | 0.71 | *** | Supported | 0.94 | *** | Supported |
| H5: ATT↔PBC | 0.83 | *** | Supported | 0.71 | *** | Supported | 0.75 | *** | Supported | 0.59 | *** | Supported |
| H6: SN↔PBC | 0.74 | *** | Supported | 0.84 | *** | Supported | 0.67 | *** | Supported | 0.73 | *** | Supported |
| H7: PR ⟶ BI | −0.15 | *** | Supported | −0.24 | *** | Supported | −0.48 | *** | Supported | −0.09 | 0.03 | Supported |
| H8: PB ⟶ BI | 0.71 | *** | Supported | 1.00 | *** | Supported | 0.96 | *** | Supported | 0.54 | *** | Supported |
| H9: PR↔PB | 0.51 | *** | Supported | 0.75 | *** | Supported | 0.52 | *** | Supported | 0.32 | *** | Supported |
| H10: PR↔ATT | 0.37 | *** | Supported | 0.53 | *** | Supported | 0.40 | *** | Supported | 0.35 | *** | Supported |
| H10: PR↔SN | 0.33 | *** | Supported | 0.65 | *** | Supported | 0.35 | *** | Supported | 0.31 | *** | Supported |
| H10: PR↔PBC | 0.48 | *** | Supported | 0.70 | *** | Supported | 0.47 | *** | Supported | 0.24 | *** | Supported |
| H11: PB↔ATT | 0.77 | *** | Supported | 0.80 | *** | Supported | 0.83 | *** | Supported | 0.76 | *** | Supported |
| H11: PB↔SN | 0.71 | *** | Supported | 0.91 | *** | Supported | 0.73 | *** | Supported | 0.80 | *** | Supported |
| H11: PB↔PBC | 0.87 | *** | Supported | 0.84 | *** | Supported | 0.84 | *** | Supported | 0.64 | *** | Supported |

Note: *** represents $P < 0.01$. All values are rounded to the second decimal point. PC indicates path coefficient; PV represents $P$ value.

Table 7: Comparison of influence degree of psychological factors.

| Cities | Rank of direct influence factors | Rank of indirect influence factors | Mediating variables |
|---|---|---|---|
| First-tier cities | PB > ATT > PR | PBC > SN | ATT > PB |
| Second-tier cities | PB > PR > ATT | SN > PBC | PB > ATT > PR |
| Third-tier cities | PB > PR > ATT | PBC > SN | PB > ATT |
| Fourth-tier cities | PB > SN > PBC > ATT > PR | - | - |

*Note.* ">" indicates comparison of the degree of influence.

(5) PB have a significant positive impact on BI, and the impact level is greater than the effect of PR on BI, so H8 is supported, indicating that the potential income generated by unused parking spaces may be a strong motivation for parking space owners, but this does not necessarily conform to the views of other stakeholders (such as family members). The PB has little direct impact on BI in first-tier and fourth-tier cities, which may be due to the relatively high level of economic development in first-tier cities and the overall insensitivity of suppliers to shared parking revenues, while in fourth-tier cities, parking pressure is relatively low; thus the supplier perceives less benefit. Besides, PBC, SN, and PB all have significant effects on each other, thus partially verifying H10 and H11.

## 5. Policy Application

Based on the above results, the following policy recommendations are put forward.

*5.1. Enhance the Public's Understanding of Shared Parking Projects.* According to the analysis result (2), in the SEMs of different levels of cities, ATT has a significant positive impact on BI. In first-tier and third-tier cities, the influence of ATT on BI is greater. Therefore, if the shared parking operation platform wants to develop the shared parking projects in the first-tier and third-tier cities, it can cooperate with the government and take measures to enhance the public's understanding of shared parking, to promote the public's intention to participate in shared parking projects.

*5.2. Strengthen the Publicity of the Shared Parking Projects and Improve the Ease of Use of System Particularly in the Fourth-Tier Cities.* Only in the fourth-tier cities, SN and PBC have a significant positive impact on BI, indicating that the decision-making of this group is more susceptible to the influence of relatives, friends, and government. They also pay more attention to related operating systems. Therefore, in order to promote shared parking plans in fourth-tier cities, in addition to enhancing the public's awareness of shared parking, attention should also be paid to reducing the complexity of the use of shared parking operating systems and strengthening relevant instructions. These recommendations are reflected in measurement items SN1–SN8 and PBC5 in Table 1.

*5.3. Establish the Safety Supervision Mechanism and Revenue Feedback Mechanism.* In response to the analysis result (4), PR has a negative effect on BI. Especially in third-tier cities, PR has the greatest negative effect on BI, so in third-tier cities stakeholders should pay more attention to establish the safety supervision mechanism for shared parking to reduce safety risks and cost risks, these policies are reflected in measurement items PR1-PR5 in Table 1. Among them, the supervision mechanism should be led by the operator and cooperate with other stakeholders. For example, if the safety and privacy of residents are violated by externally parked vehicles, punitive measures

such as parking restrictions and violation of personal credit records should be implemented. Secondly, the community awareness can be enhanced by supplying a brief introduction to the operation of the shared parking system, discussing safety issues with community members, and developing ways to give back to the community. Community residents and landowners with private roads can benefit from this and reach a community consensus; these recommendations are reflected in measurement items PBC6 and SN5 in Table 1.

*5.4. Enhance the Attractiveness of Participation Benefits and Carry out Shared Parking Demonstration Projects.* According to the analysis result (5), PB is the latent variable that has the greatest direct impact on BI, especially in second-tier and third-tier cities, shared parking space suppliers' BI are more affected by PB, so in second- and third-tier cities, it is more important to enhance the attractiveness of parking space sharing. However, there are many interested parties involved in sharing parking spaces, including operating platforms, properties, and parking space suppliers. It is difficult for shared revenue to meet the expectations of parking space suppliers. Although the government is not a profit-making organization in China, shared parking can generate more social benefits, such as reducing vacant parking spaces and reducing parking and traffic congestion. Therefore, the government should support financial subsidies to reduce the cost pressure on suppliers and managers. In addition, shared parking demonstration projects also require government investment. Demonstration of shared parking projects can improve the public's perception of potential personal and public benefits. Shared parking demonstration projects should be implemented by the government, suppliers, and managers, and the implementation effects and social values of shared parking should be broadcast to the public. Through demonstration projects, the benefits and risks will be clearer in practice, thereby eliminating the anxiety of suppliers. In addition, the promotion plan can be gradually expanded according to land use types, employment distribution, and development status. In addition, the operating platform also needs to develop strategies to promote shared parking in the community for different participant groups. The government and community committees can discuss the most suitable business model for the community.

## 6. Conclusions

This study aims to explore the intention of private parking space owners of different levels of cities to participate in shared parking in China and the action mechanism of psychological factors on sharing intention. Therefore, we constructed combined theoretical framework (C-TPB-BRA) and used the structural equation model to verify the relationship between the psychological factors. Our results show that the combined theoretical framework has a high explanatory ability, which confirms that the combination of TPB and BRA model can explain the differences in the sharing intentions of private car space owners in cities of different levels.

This research has made many contributions both in theory and in practice. To our knowledge, this is the first study to apply C-TPB-BRA to explore suppliers' intention to offer shared parking spaces. This research could also help for decision makers to formulate smart city construction strategies. Intelligent parking systems will eventually become an integral part of all communities, and shared parking will undoubtedly play an important role [56].

According to the research results, PB has the greatest direct impact on BI, not all psychological variables will directly affect the parking sharing intention, but some psychological variables indirectly affect the sharing intention through other psychological variables, which may be due to the structure of these psychological factors and emerging technologies caused by contact problems. One reason is that psychological variables are mostly imported from foreign research, and their applicability in China needs to be studied and must be verified by many domestic empirical studies. The second reason is that shared parking has not been widely used in real life, and the public's perception still needs to be improved.

In future research, researchers can seek to confirm the selection results of suppliers under different cultural backgrounds and discuss the sensitivity of suppliers to policy variables such as fees. In addition, the intention to share parking space is also affected by other family members, so the perspective of family as a unit is worth further study.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

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